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A

TIDE TABLE,

Shewing the (Solar) TIMES of

HIGH WATER,

AND ALSO

The HEIGHTS of the TIDES,

AT THE

CUSTOM-HOUSE DOCK-GATES,

LIVERPOOL;

For the YEAR 1781.

WITH

Some New Aſtronomical PROBLEMS,

Which will be very uſeful at Sea.

Publiſhed by Order of
The Worſhipful the MAYOR, BAILIFFS, and
Gentlemen of the COMMON-COUNCIL
of *LIVERPOOL*.

Calculated by the Rev. Mr G. HOLDEN,
And his SON,
According to the Theory of the late Mr R. HOLDEN.

[*To be continued Yearly.*]

Thou haſt ſet them their Bounds, which they ſhall not paſs.

PSAL. civ. v. 9.

PRINTED AND SOLD BY J. SIBBALD.
(Pri[illegible]e Shilling.)

o the Worſhipfu [illegible] Mayor, Bailiffs, *and*
Gentlemen *of the* Common Council, *and to*
the Merchants *and* Tradeſmen *of Liverpool*,
This TIDE TABLE is HUMBLY INSCRIBED,
By their moſt obedient Servant,

Geo: Holden

The PREFACE.

A Perfect Theory of the Tides, and an accurate method of calculating them, have been greatly wanted in every age, ſince Navigation was firſt practiſed; and, tho' induſtriouſly ſought after, have hitherto baffled the reſearches of the moſt learned; for the theory has never before been ſufficiently perfected.—And as the theory has hitherto remained defective, ſo the methods of calculation, founded thereupon, have ſucceeded no better; for (as I am now furniſhed with above 4900 obſervations made upon the tides at Liverpool, and 360 at Bristol, with which I can compare my own, and all other methods of calculation) I think I may venture to aſſert, that all the methods given us in books of navigation, and all the tide tables inſerted in our almanacks, are very frequently ſubject to the error of an hour, and many times of much more; except that of Monſieur de la Caille, which yet is often liable to an error of forty minutes, as any perſon will find who takes the trouble of making a ſufficient number of obſervations.

Indeed no perſon can expect that it ſhould be otherwiſe, who conſiders, that both Monſieur de la Caille's, and all other methods (except that of Monſieur Cassini, which in truth is no better) depend entirely upon the moon's age, or her diſtance from the ſun, without regarding the different diſtances of either the ſun or moon from the earth, their declinations, the latitudes of places, or any thing elſe that affects the tides; whereas a proper allowance has been made, in this table, for every

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thing that can produce any material irregularity in the tides; except the wind, the true effects of which cannot be aſcertained by any method of computation hitherto found out.

Thus deficient are all former methods of computing, ONLY the TIMES of High Water; as for the HEIGHTS, the calculation thereof has never before been attempted by any one, that I know of; tho' they are, as I apprehend, equally neceſſary; for of what advantage can it be to the ſeaman to know when the tides will be at the higheſt, if there will not be, at that time, depth of water ſufficient for his purpoſe? Indeed it would be of no more ſervice o know that there would be depth enough of water, nleſs he know at the ſame time when to expect it. But to know what HEIGHT the tide will riſe to, and t what TIME, muſt contribute greatly to his ſecurity; and is it not abſolutely requiſite that a tide table ſhould inform him of both theſe?

I have in this only given the heights (in feet and nches) of thoſe tides which come between the hours of 6 in the morning and 6 in the evening, which will always be ſufficient, as the night tides may be known accurately enough from them, being ſomething lower in the months January, February, March, April, November, and December, and higher in all the other months.

If any perſon ſhall think proper to compare this table with his own obſervations, he ought always to ſet his watch right, immediately before, by ſome good ſun-dial; for theſe calculations are made according to ſolar time.

The beſt way of regulating a watch at ſea, is by a new method of calculation from an obſerved altitude of the ſun, or ſome fixed ſtar; which method is explained at the end of this book. But if this be thought too troubleſome, it may be done with the greateſt eaſe by a large Univerſal Ring Dial, which will ſhew the true time of the day, by inſpection, when properly ſet to the latitude of the place, and declination of the ſun; or, for Liverpool, Holyhead, Dublin, &c. it may be do[illegible] by the following table, t the riſing or ſetting of the ſun.

A TABLE, *ſhewing the Time of the* SUN's SETTING, *for the Latitude of* LIVERPOOL, *for the Year* 1781, *to every third Day*, (Refraction *allow'd for.*)

DAYS.	3		6		9		12		15		18		21		24		27		30	
	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
January	3	47	3	50	3	53	3	56	4	0	4	5	4	9	4	14	4	19	4	24
February	4	31	4	37	4	43	4	49	4	55	5	1	5	7	5	14	5	20	—	—
March	5	28	5	35	5	41	5	47	5	54	6	0	6	6	6	13	6	19	6	25
April	6	34	6	40	6	46	6	52	6	59	7	5	7	11	7	17	7	23	7	28
May	7	34	7	39	7	45	7	50	7	55	8	0	8	4	8	8	8	12	8	16
June	8	19	8	22	8	24	8	26	8	27	8	28	8	28	8	28	8	27	8	26
July	8	23	8	21	8	18	8	16	8	12	8	9	8	5	8	0	7	55	7	51
Auguſt	7	44	7	39	7	33	7	28	7	22	7	16	7	10	7	4	6	58	6	52
September	6	44	6	37	6	31	6	25	6	19	6	13	6	6	5	59	5	54	5	47
October	5	41	5	35	5	28	5	22	5	16	5	10	5	4	4	58	4	52	4	46
November	4	38	4	32	4	27	4	21	4	16	4	11	4	7	4	2	3	58	3	55
December	3	51	3	49	3	46	3	44	3	43	3	42	3	42	3	42	3	43	3	45

JANUARY, 1781.

	D.	H.	M.		D.	H.	M.
Firſt Qr.	2	8	1 E.	Full Moon	10	8	51M.
Laſt Qr.	17	1	40M.	New Moon	24	11	58M.

DAYS.		Morn.		Even.		Heights		Clock bef. Sun.
		H.	M.	H.	M	F.	I.	M.
Monday	1	3	3	3	24	13	0	4
Tueſday	2	3	47	4	11	12	4	5
Wedneſday	3	4	37	5	4	11	9	
Thurſday	4	5	34	6	6	11	8	
Friday	5	6	38	7	10	11	10	6
Saturday	6	7	44	8	13	12	6	
SUNDAY	7	8	41	9	7	13	5	7
Monday	8	9	31	9	55	14	5	
Tueſday	9	10	18	10	40	15	5	8
Wedneſday	10	11	2	11	24	16	5	
Thurſday	11	11	45	—	—	17	4	
Friday	12	0	7	0	28	18	0	9
Saturday	13	0	50	1	13	18	3	
SUNDAY	14	1	36	1	59	18	1	
Monday	15	2	22	2	46	17	6	10
Tueſday	16	3	11	3	37	16	8	
Wedneſday	17	4	4	4	34	15	6	
Thurſday	18	5	4	5	37	14	6	11
Friday	19	6	11	6	50	13	8	
Saturday	20	7	27	8	5	13	5	
SUNDAY	21	8	39	9	9	13	10	12
Monday	22	9	37	10	3	14	4	
Tueſday	23	10	28	10	50	14	11	
Wedneſday	24	11	10	11	29	15	6	
Thurſday	25	11	48	—	—	16	0	13
Friday	26	0	5	0	24	16	2	
Saturday	27	0	41	0	57	16	2	
SUNDAY	28	1	14	1	30	15	10	
Monday	29	1	46	2	3	15	4	
Tueſday	30	2	19	2	36	14	7	
Wedneſday	31	2	54	3	12	13	8	14

FEBRUARY, 1781.

D. H. M. D. H. M.
Firſt Qr. 1 4 43 E. Full Moon 8 8 15 E.
Laſt Qr. 15 11 35 M. New Moon 23 5 42 M.

DAYS.		Morn.		Even.		Heights		Clock bef. Sun.
		H.	M	H.	M	F	I.	M.
Thurſday	1	3	32	3	54	12	10	
Friday	2	4	17	4	44	11	11	
Saturday	3	5	16	5	52	11	4	
SUNDAY	4	6	28	7	7	11	2	
Monday	5	7	47	8	22	11	11	14½
Tueſday	6	8	54	9	22	13	4	
Wedneſday	7	9	50	10	15	14	10	
Thurſday	8	10	39	11	3	16	6	
Friday	9	11	25	11	48	18	2	
Saturday	10	——		0	10	19	6	
SUNDAY	11	0	32	0	54	20	3	
Monday	12	1	15	1	37	20	3	
Tueſday	13	1	58	2	20	19	5	
Wedneſday	14	2	42	3	6	17	10	
Thurſday	15	3	29	3	56	15	9	14½
Friday	16	4	23	4	55	13	9	
Saturday	17	5	31	6	11	12	4	
SUNDAY	18	6	57	7	41	11	7	
Monday	19	8	21	8	55	12	1	
Tueſday	20	9	26	9	53	13	2	14
Wedneſday	21	10	17	10	36	14	2	
Thurſday	22	10	55	11	13	15	2	
Friday	23	11	30	11	46	16	1	
Saturday	24	——		0	2	16	7	
SUNDAY	25	0	17	0	32	16	11	
Monday	26	0	47	1	2	16	9	13
Tueſday	27	1	17	1	32	16	4	
Wedneſday	28	1	46	2	1	15	7	

MARCH, 1781.

	D.	H.	M.		D.	H.	M.
Firſt Qr.	3	10	22 M.	Full Moon	10	6	19 M.
Laſt Qr.	16	11	13 E.	New Moon	24	11	54 E.

DAYS.		Morn.		Even.		Heights		Clock bef. Sun.
		H.	M.	H.	M.	F.	I.	M.
Thurſday	1	2	17	2	33	14	7	
Friday	2	2	52	3	12	13	4	
Saturday	3	3	33	3	57	12	2	
SUNDAY	4	4	26	4	59	11	0	12
Monday	5	5	42	6	28	10	9	
Tueſday	6	7	16	7	58	11	3	
Wedneſday	7	8	36	9	8	13	0	
Thurſday	8	9	36	10	2	15	1	11
Friday	9	10	24	10	47	17	5	
Saturday	10	11	10	11	32	19	6	
SUNDAY	11	11	53	—	—	21	2	10
Monday	12	0	14	0	33	21	9	
Tueſday	13	0	53	1	15	21	4	
Wedneſday	14	1	35	1	57	19	10	
Thurſday	15	2	19	2	42	17	8	9
Friday	16	3	5	3	30	15	0	
Saturday	17	3	57	4	28	12	8	
SUNDAY	18	5	10	5	53	11	2	8
Monday	19	6	38	7	28	10	8	
Tueſday	20	8	12	8	46	11	6	
Wedneſday	21	9	16	9	40	12	11	
Thurſday	22	10	2	10	22	14	2	7
Friday	23	10	39	10	55	15	4	
Saturday	24	11	10	11	25	16	3	
SUNDAY	25	11	40	11	54	16	11	6
Monday	26	—	—	0	9	17	3	
Tueſday	27	0	23	0	37	17	2	
Wedneſday	28	0	52	1	5	16	9	5
Thurſday	29	1	20	1	35	15	11	
Friday	30	1	50	2	7	14	9	
Saturday	31	2	25	2	46	13	6	4

M A R C H, 1781.

	D. H. M.		D. H. M.
Firſt Qr.	3 10 22 M.	Full Moon	10 6 19M.
Laſt Qr.	16 11 13 E.	New Moon	24 11 54 E.

DAYS.		Morn.		Even.		Heights		Clock bef. Sun.
		H.	M.	H.	M.	F.	I.	M.
Thurſday	1	2	17	2	33	14	7	
Friday	2	2	52	3	12	13	4	
Saturday	3	3	33	3	57	12	2	
SUNDAY	4	4	26	4	59	11	0	12
Monday	5	5	42	6	28	10	9	
Tueſday	6	7	16	7	58	11	3	
Wedneſday	7	8	36	9	8	13	0	
Thurſday	8	9	36	10	2	15	1	11
Friday	9	10	24	10	47	17	5	
Saturday	10	11	10	11	32	19	6	
SUNDAY	11	11	53	——		21	2	10
Monday	12	0	14	0	33	21	9	
Tueſday	13	0	53	1	15	21	4	
Wedneſday	14	1	35	1	57	19	10	
Thurſday	15	2	19	2	42	17	8	9
Friday	16	3	5	3	30	15	0	
Saturday	17	3	57	4	28	12	8	
SUNDAY	18	5	10	5	53	11	2	8
Monday	19	6	38	7	28	10	8	
Tueſday	20	8	12	8	46	11	6	
Wedneſday	21	9	16	9	40	12	11	
Thurſday	22	10	2	10	22	14	2	7
Friday	23	10	39	10	55	15	4	
Saturday	24	11	10	11	25	16	3	
SUNDAY	25	11	40	11	54	16	11	6
Monday	26	——		0	9	17	3	
Tueſday	27	0	23	0	37	17	2	
Wedneſday	28	0	52	1	5	16	9	5
Thurſday	29	1	20	1	35	15	11	
Friday	30	1	50	2	7	14	9	
Saturday	31	2	25	2	46	13	6	4

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APRIL, 1781.

	D. H. M.		D. H. M.
Firſt Qr.	1 11 50 E.	Full Moon	8 3 28 E.
Laſt Qr.	15 1 3 E.	New Moon	23 5 8 E.
Firſt Qr.	31 9 14 M.		

	DAYS.		Morn.		Even.		Height		Clock bef. Sun.
			H.	M	H.	M.	F.	I.	M.
	SUNDAY	1	3	9	3	34	12	0	
	Monday	2	4	4	4	39	10	10	
	Tueſday	3	5	26	6	16	10	8	
	Wedneſday	4	7	5	7	46	11	6	3
	Thurſday	5	8	23	8	53	13	8	
	Friday	6	9	21	9	48	16	2	
	Saturday	7	10	10	10	33	18	5	2
	SUNDAY	8	10	53	11	14	20	5	
	Monday	9	11	35	11	56	21	7	
	Tueſday	10	———		0	16	21	9	1
2	Wedneſday	11	0	37	0	58	20	10	
	Thurſday	12	1	20	1	41	18	10	
	Friday	13	2	1	2	24	16	6	
	Saturday	14	2	48	3	13	14	1	0
	SUNDAY	15	3	42	4	16	12	0	
	Monday	16	4	56	5	38	10	8	After.
	Tueſday	17	6	27	7	13	10	6	
3	Wedneſday	18	7	55	8	26	11	6	
	Thurſday	19	8	54	9	18	12	11	1
	Friday	20	9	40	9	59	14	2	
	Saturday	21	10	16	10	32	15	3	
	SUNDAY	22	10	46	11	1	16	4	
	Monday	23	11	16	11	30	16	10	
	Tueſday	24	11	45	11	59	17	2	2
4	Wedneſday	25	———		0	14	17	1	
	Thurſday	26	0	29	0	43	16	8	
	Friday	27	0	59	1	15	15	11	
	Saturday	28	1	33	1	52	14	8	
	SUNDAY	29	2	12	2	32	13	6	
	Monday	30	2	57	3	24	11	3	3

M A Y, 1781.

	D.H.M.			D.H.M.
Full Moon	8 0 5 M.		Laſt Qr.	15 4 9 M.
New Moon	23 8 8 M.		Firſt Qr.	30 3 34 E.

	DAYS.		Morn.		Even.		Heights		Clock aft. Sun.	
			H.	M.	H.	M.	F.	I.	M.	
	Tueſday	1	3	57	4	34	11	3		
	Wedneſday	2	5	19	6	6	11	6		
	Thurſday	3	6	51	7	28	12	3		
	Friday	4	8	4	8	34	14	9	3½	
	Saturday	5	9	1	9	26	17	1		
	SUNDAY	6	9	49	10	12	18	10		went to Lond.
	Monday	7	10	33	10	54	19	11		
6	Tueſday	8	11	14	11	36	20	9		at London
	Wedneſday	9	11	58	—	—	20	5		
	Thurſday	10	0	19	0	41	18	5		
	Friday	11	1	2	1	25	16	10		
	Saturday	12	1	47	2	9	15	0		
	SUNDAY	13	2	33	2	59	13	3	4	
	Monday	14	3	27	3	56	11	8		
	Tueſday	15	4	31	5	9	10	10		
7	Wedneſday	16	5	50	6	30	11	0	4	
	Thurſday	17	7	9	7	43	11	5		
	Friday	18	8	13	8	38	12	4		
	Saturday	19	8	59	9	20	13	5		— parted
	SUNDAY	20	9	39	9	57	14	5		Samwell
8	Monday	21	10	14	10	30	15	2		
	Tueſday	22	10	46	11	1	15	8		
	Wedneſday	23	11	18	11	35	16	0		
	Thurſday	24	11	51	—	—	15	11	3½	
	Friday	25	0	7	0	23	15	7		
	Saturday	26	0	41	1	0	15	0		
9	*SUNDAY*	27	1	20	1	39	14	4		left London
	Monday	28	2	0	2	25	13	6		
	Tueſday	29	2	51	3	18	12	9	3	
	Wedneſday	30	3	49	4	22	12	5		
	Thurſday	31	5	1	5	42	12	10		returned —

JUNE, 1781.

	D.H.M.		D H.M.
Full Moon	6 8 40M.	Laſt Qr.	13 8 52 E.
New Moon	21 8 21 E.	Firſt Qr.	28 8 15 E.

	DAYS.		Morn.		Even.		Heights		Clock aft. Sun.
			H.	M.	H.	M.	F.	I.	M.
	Friday	1	6	20	6	55	13	11	
	Saturday	2	7	30	8	1	15	0	
	SUNDAY	3	8	30	8	56	16	5	
10	Monday	4	9	20	9	49	17	6	2
	Tueſday	5	10	10	10	33	18	1	
	Wedneſday	6	10	56	11	18	18	3	
	Thurſday	7	11	41	—	—	17	9	
	Friday	8	0	3	0	25	16	11	
	Saturday	9	0	47	1	8	15	10	
	SUNDAY	10	1	30	1	51	14	9	1
11	Monday	11	2	14	2	36	13	6	
	Tueſday	12	3	1	3	24	12	7	
	Wedneſday	13	3	49	4	17	11	9	
	Thurſday	14	4	49	5	22	11	6	
	Friday	15	5	55	6	28	11	8	0
	Saturday	16	7	2	7	33	11	10	Before.
	SUNDAY	17	8	1	8	25	12	5	
12	Monday	18	8	48	9	10	13	2	
	Tueſday	19	9	32	9	52	14	0	
	Wedneſday	20	10	12	10	31	14	7	1
	Thurſday	21	10	50	11	9	15	2	
	Friday	22	11	27	11	46	15	5	
	Saturday	23	—	—	0	7	15	8	
	SUNDAY	24	0	26	0	46	15	8	2
13	Monday	25	1	8	1	28	15	5	
	Tueſday	26	1	52	2	14	15	1	
	Wedneſday	27	2	39	3	5	14	10	
	Thurſday	28	3	31	4	0	14	6	
	Friday	29	4	30	5	3	14	3	3
	Saturday	30	5	36	6	9	14	8	

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JULY, 1781.

	D.	H	M.		D.	H	M.
Full Moon	5	6	5 E.	Laſt Qr.	13	2	12 E.
New Moon	21	6	20 M.	Firſt Qr.	28	0	52 M.

DAYS.		Morn.		Even.		Heights		Clock bef. Sun.
		H.	M.	H.	M	F.	I	M.
SUNDAY	1	6	47	7	21	14	9	
Monday	2	7	54	8	26	14	11	
Tueſday	3	8	56	9	24	15	5	
Wedneſday	4	9	52	10	18	15	9	4
Thurſday	5	10	43	11	5	16	2	
Friday	6	11	28	11	50	16	4	
Saturday	7	—	—	0	11	16	2	
SUNDAY	8	0	32	0	50	15	8	
Monday	9	1	10	1	30	15	2	—Kelsall
Tueſday	10	1	50	2	8	14	7	
Wedneſday	11	2	28	2	48	13	11	5
Thurſday	12	3	8	3	29	13	1	
Friday	13	3	50	4	13	12	3	
Saturday	14	4	39	5	7	11	8	
SUNDAY	15	5	37	6	11	11	7	
Monday	16	6	43	7	19	11	5	5½
Tueſday	17	7	54	8	23	11	4	
Wedneſday	18	8	51	9	17	12	5	
Thurſday	19	9	42	10	5	13	6	
Friday	20	10	28	10	49	14	6	
Saturday	21	11	9	11	31	15	6	
SUNDAY	22	11	51	—	—	16	4	
Monday	23	0	12	0	33	16	11	6
Tueſday	24	0	54	1	16	17	3	
Wedneſday	25	1	37	2	0	17	5	
Thurſday	26	2	22	2	44	17	6	
Friday	27	3	7	3	32	16	4	
Saturday	28	3	58	4	27	15	2	
SUNDAY	29	4	55	5	29	14	3	
Monday	30	6	4	6	46	14	6	
Tueſday	31	7	25	8	3	13	0	7

AUGUST, 1781.

	D.	H.	M.			D.	H.	M.
Full Moon	4	5	18M.		Laſt Qr.	12	7	34 M.
New Moon	19	3	7E.		Firſt Qr.	26	6	50 M.

DAYS.		Morn.		Even.		Heights		Clock bef. Sun.
		H.	M.	H.	M.	F.	I	M.
Wedneſday	1	8	43	9	14	13	4	
Thurſday	2	9	44	10	10	14	4	
Friday	3	10	35	10	57	15	0	
Saturday	4	11	19	11	39	15	7	
SUNDAY	5	11	57	—	—	15	11	5½
Monday	6	0	15	0	33	16	[illegible]	
Tueſday	7	0	51	1	7	15	11	
Wedneſday	8	1	24	1	39	15	6	
Thurſday	9	1	56	2	12	14	11	5
Friday	10	2	29	2	45	14	1	
Saturday	11	3	4	3	22	13	1	
SUNDAY	12	3	41	4	5	11	11	
Monday	13	4	31	5	2	11	0	
Tueſday	14	5	39	6	17	10	9	
Wedneſday	15	7	0	7	41	10	8	4
Thurſday	16	8	19	8	51	11	5	
Friday	17	9	21	9	45	12	11	
Saturday	18	10	11	10	33	14	7	
SUNDAY	19	10	56	11	17	16	4	
Monday	20	11	38	11	59	17	9	3
Tueſday	21	—	—	0	20	18	11	
Wedneſday	22	0	39	1	0	19	5	
Thurſday	23	1	21	1	42	19	4	
Friday	24	2	2	2	24	18	5	2
Saturday	25	2	45	3	10	16	11	
SUNDAY	26	3	34	4	2	14	10	
Monday	27	4	32	5	7	13	0	1
Tueſday	28	5	48	6	32	12	1	
Wedneſday	29	7	20	8	4	11	7	
Thurſday	30	8	44	9	16	12	3	
Friday	31	9	44	10	10	13	6	0

SEPTEMBER, 1781.

	D.	H.	M.		D.	H.	M.
Full Moon	2	7	12 E.	Laſt Qr.	10	11	58 E.
New Moon	17	11	45 E.	Firſt Qr.	24	3	21 E.

DAYS.		Morn.		Even.		Heights		Clock aft. Sun.
		H.	M	H.	M	F.	I.	M.
Saturday	1	10	29	10	48	14	8	
SUNDAY	2	11	9	11	26	15	8	
Monday	3	11	43	11	59	16	3	1
Tueſday	4	—	—	0	15	16	6	
Wedneſday	5	0	31	0	46	16	5	
Thurſday	6	1	1	1	14	15	1	2
Friday	7	1	29	1	43	15	5	
Saturday	8	1	59	2	14	14	5	
SUNDAY	9	2	30	2	48	13	3	3
Monday	10	3	6	3	27	11	11	
Tueſday	11	3	52	4	21	10	8	
Wedneſday	12	4	57	5	37	10	1	4
Thurſday	13	6	27	7	14	10	4	
Friday	14	8	0	8	36	11	3	
Saturday	15	9	6	9	33	13	3	5
SUNDAY	16	9	58	10	21	15	4	
Monday	17	10	42	11	4	17	7	
Tueſday	18	11	24	11	43	19	5	6
Wedneſday	19	—	—	0	2	20	7	
Thurſday	20	0	23	0	42	20	10	
Friday	21	1	1	1	26	20	0	7
Saturday	22	1	45	2	8	18	5	
SUNDAY	23	2	29	2	53	16	1	8
Monday	24	3	18	3	47	13	9	
Tueſday	25	4	20	4	58	12	0	
Wedneſday	26	5	44	6	33	11	2	9
Thurſday	27	7	22	8	6	11	2	
Friday	28	8	44	9	13	12	2	
Saturday	29	9	38	9	59	13	6	10
SUNDAY	30	10	18	10	36	14	9	

OCTOBER, 1781.

	D.	H.	M.		D.	H.	M.
Full Moon	2	11	49M.	Laſt Qr.	10	2	37 E.
New Moon	17	8	56M.	Firſt Qr.	24	3	22M.

DAYS.		Morn.		Even.		Heights		Clock aft. Sun.
		H.	M.	H.	M.	F.	I.	M.
Monday	1	10	54	11	10	15	10	10½
Tueſday	2	11	25	11	39	16	5	
Wedneſday	3	11	53	—	—	16	8	11
Thurſday	4	0	7	0	22	16	6	
Friday	5	0	36	0	50	16	0	
Saturday	6	1	5	1	19	15	3	12
SUNDAY	7	1	33	1	49	14	3	
Monday	8	2	5	2	22	13	1	
Tueſday	9	2	42	3	3	11	10	
Wedneſday	10	3	30	3	59	10	8	13
Thurſday	11	4	37	5	21	10	1	
Friday	12	6	12	6	57	10	7	
Saturday	13	7	42	8	17	11	10	
SUNDAY	14	8	49	9	17	14	1	14
Monday	15	9	38	10	0	16	6	
Tueſday	16	10	22	10	44	18	8	
Wedneſday	17	11	3	11	24	20	4	
Thurſday	18	11	44	—	—	21	1	
Friday	19	0	6	0	25	20	8	15
Saturday	20	0	45	1	7	19	4	
SUNDAY	21	1	29	1	54	17	4	
Monday	22	2	16	2	42	15	1	
Tueſday	23	3	8	3	36	13	0	[illegible]
Wedneſday	24	4	10	4	50	11	3	
Thurſday	25	5	38	6	24	11	1	
Friday	26	7	8	7	48	11	2	
Saturday	27	8	21	8	49	12	3	16
SUNDAY	28	9	12	9	33	13	7	
Monday	29	9	53	10	10	14	8	
Tueſday	30	10	27	10	44	15	6	
Wedneſday	31	10	59	11	14	16	2	

NOVEMBER, 1781.

	D.	H.	M.		D.	H.	M.
Full Moon	1	6	16 M.	Laſt Qr.	9	3	8 M.
New Moon	15	6	59 E.	Firſt Qr.	22	7	19 E.

DAYS.		Morn.		Even.		Heights		Clock aft. Sun.	
		H.	M.	H.	M.	F.	I	M.	
Thurſday	1	11	28	11	43	16	3	16¼	
Friday	2	11	57	—		16	2		
Saturday	3	0	11	0	26	15	8		
SUNDAY	4	0	42	0	57	14	11		
Monday	5	1	12	1	29	14	1		
Tueſday	6	1	47	2	6	13	1		
Wedneſday	7	2	26	2	50	11	1		
Thurſday	8	3	17	3	47	11	2	16	
Friday	9	4	21	5	1	10	9		← Bullen
Saturday	10	5	49	6	30	11	8		
SUNDAY	11	7	10	7	46	12	11		
Monday	12	8	16	8	43	15	3		Pownel.
Tueſday	13	9	7	9	31	17	5		
Wedneſday	14	9	53	10	16	19	1		
Thurſday	15	10	38	11	0	20	3	15	
Friday	16	11	21	11	45	20	7		
Saturday	17	—		0	6	20	2		
SUNDAY	18	0	28	0	50	18	11		
Monday	19	1	13	1	37	17	2		
Tueſday	20	2	2	2	26	15	2	14	
Wedneſday	21	2	51	3	19	13	6		
Thurſday	22	3	50	4	23	12	2		
Friday	23	5	2	5	37	11	5	13	
Saturday	24	6	16	6	52	11	7		
SUNDAY	25	7	28	7	58	12	4		
Monday	26	8	25	8	48	13	3	12	
Tueſday	27	9	10	9	29	14	3		
Wedneſday	28	9	47	10	5	14	11		
Thurſday	29	10	23	10	39	15	5	11	
Friday	30	10	57	11	13	15	9		

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DECEMBER, 1781.

	D.	H.	M.		D.	H.	M.
Full Moon	1	0	42 M.	Laſt Qr.	8	1	36 E.
New Moon	15	6	2 M.	Firſt Qr.	22	2	51 E.
Full Moon	30	5	41 E.				

DAYS.		Morn. H.	Morn. M.	Even. H.	Even. M.	Heights F.	Heights I.	Clock aft. Sun. M.
Saturday	1	11	27	11	43	15	11	
SUNDAY	2	—	—	0	1	16	0	10
Monday	3	0	17	0	35	15	9	
Tueſday	4	0	53	1	12	15	1	9
Wedneſday	5	1	30	1	50	14	5	
Thurſday	6	2	13	2	35	13	8	
Friday	7	3	2	3	27	13	1	8
Saturday	8	4	0	4	28	12	9	
SUNDAY	9	5	6	5	43	13	0	7
Monday	10	6	17	6	55	13	11	
Tueſday	11	7	25	7	56	15	2	6
Wedneſday	12	8	25	8	53	16	7	
Thurſday	13	9	18	9	43	17	7	5
Friday	14	10	7	10	31	18	1	
Saturday	15	10	56	11	20	18	5	4
SUNDAY	16	11	44	—	—	18	3	
Monday	17	0	8	0	31	17	10	3
Tueſday	18	0	54	1	16	17	1	
Wedneſday	19	1	39	2	1	15	9	2
Thurſday	20	2	24	2	49	14	7	
Friday	21	3	12	3	37	13	6	1
Saturday	22	4	2	4	28	12	8	
SUNDAY	23	4	57	5	28	12	1	0
Monday	24	6	0	6	32	11	11	
Tueſday	25	7	4	7	33	11	11	1
Wedneſday	26	8	2	8	29	12	5	
Thurſday	27	8	53	9	16	13	1	2
Friday	28	9	39	10	0	13	10	
Saturday	29	10	20	10	39	14	5	
SUNDAY	30	10	58	11	16	15	1	3
Monday	31	11	34	11	53	15	6	

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SOME NEW
Aſtronomical PROBLEMS,
Which may be uſeful at Sea.

PROBLEM I. *To find the true time of the Sun's Setting, corrected for the refraction of light, (the latitude and ſun's declination being known.)*

RULE. Add 96 to the natural ſine of the ſun's meridian altitude, (taken out of Sherwin's tables) annex three cyphers to the ſum, then to the logarithm of that number (conſidering all the figures as integers) add the log. ſecant of the latitude, and the log. ſecant of the ſun's declination, (abating 10 from the index of each ſecant) and the ſum of theſe three logarithms will be the log. ver. ſine of the horary angle, or time from noon, of the ſun's ſetting, corrected for the refraction of light.——N. B. The above mentioned 96 muſt be added to the whole numbers of the natural ſine; for all the natural ſines in Sherwin's tables are carried to three places of decimals; from which tables the ſecants, and verſed ſines alſo, muſt be taken.

EXAMPLE. In the latitude 53° 21′ N. when will the ſun ſet on the 21ſt day of December, 1781?

		Log.
From the complement of the lat.	36° 39′	
Subtract the ſun's declination,	23 28	
The remainder is the merid. alt.	13 11	
The natural ſine is	2280.677	
Add	96.	
The ſum, with three cyphers annexed,	2376.677000=	9.375.9702
Add the log. ſecant of the lat. 53° 21′ rejecting the index,		0.224.0801
And the log. ſec. of the ſun's dec. 23° 28′, rejecting the index,		0.037.4924
The ſum is the log. V. S. of the hor. angle (or time from noon) 55° 32′		9 637.5427

Which, turned into time, gives 3 hours, 42 minutes, and 8 ſeconds,=the time of the ſun's ſetting, corrected for refraction: This time, ſubtracted from

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12 hours, gives 8h. 17m. 52ſ. for the time of the ſun's riſing that day.

PROBLEM II. *To find any angle which exceeds 90 degrees from its log. verſed ſine.—This will be neceſſary when the index of the verſed ſine is 10, as Sherwin's tables contain the verſed ſines only to 90 degrees.*

RULE. If the index of the verſed ſine, found by the preceding rule, be 10, then find the number anſwering that log. and ſtrike off the firſt and three laſt figures; the remainder will be the natural ſine of the exceſs of the angle above 90 degrees.

EXAMPLE. In the lat. 53°″ 21′ N. when will the ſun ſet on the 21ſt day of June, 1781?

The ſun's meridian altitude is 60°″ 7′.

The natural ſine is 8670.417

Add 96.

The ſum, with three cyphers annexed, is	8766417000 =	*Log.* 9.942.8221
Add the log. ſec. of the lat. 53°″ 21′ (rejecting the index)		0.224.0801
And the log. ſec. of the declination, 23°″ 28′, (rejecting the index)		0.037.5427
The ſum is the log. verſed ſine of the horary angle, 126°″ 57′,		10.204.4449

For the numb. anſwering this log. is 1)601 1980(000. Now, ſtriking off the firſt and three laſt figures, there remains 6011.980, = the natural ſine of 36°″ 57′, the exceſs above 90°″; therefore the horary angle is 126°″ 57′, = 8h. 27m. 48ſ.

The eaſieſt method of turning degrees and minutes into time is, I believe, thus:

RULE. Conſider the degrees as minutes of time, and the minutes as ſeconds, then double them twice, thus, 126m. 57ſ, = 2h. 6m. 57ſ. which, doubled, is 4h. 13m. 54ſ. which, doubled again, is 8h. 27m. 48ſ. = the time as above.

PROBLEM III. *To find the true time when the center of the ſun will appear to be in the horizon at ſea, allowing both for the refraction of light, and the dip of the horizon.*

RULE. Increaſe the dip of the horizon (anſwering to the elevation of the eye above the ſea) by

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33m, then add the natural ſine of the dip, thus increaſed, to the natural ſine of the meridian altitude, annex three cyphers to the ſum, then to the log. of this number add the log. ſecants of the latitude and declination, (as in the firſt problem) and the ſum will be the log. ver. ſine of the horary angle from noon.—N.B. That declination ſhould be uſed which the ſun has at the time of his riſing or ſetting, and not his dec. at noon.—This will need no example.

PROBLEM IV. *To find the true time of the day from an obſerved altitude of the ſun, and thereby to regulate a watch at ſea, (the latitude and ſun's declination being known.)*

RULE. Subtract the nat. ſine of the obſerved altitude (corrected both for the refraction and dip) from the nat. ſine of the ſun's meridian altitude; annex three cyphers to the remainder; then to the log. of this number add the log. ſecants of the lat. and ſun's declination, (rejecting 10 from the index of each ſecant) and the ſum will be the log. ver. ſine of the horary angle from noon.

PROBLEM V. *To find the true time of the night from an obſerved altitude of any known fixed ſtar, and thereby to regulate a watch at ſea.*

RULE. Find the ſtar's diſtance from the meridian (*i.e.* the horary angle) by Problem IV. ſubtract the time anſwering it from the ſtar's right aſcenſion, if the ſtar be eaſt of the meridian, but if weſt, add it; and the difference or ſum will be the right aſcenſion of the mid-heaven: From which (increaſed by 24 hours, if neceſſary) ſubtract the ſun's right aſcenſion at the time of the obſervation, and the remainder will be the true time of the night.

N.B. The ſun's right aſcenſion muſt be corrected both for the longitude of the ſhip and the hour of the night.

PROBLEM VI. *To find the altitude of the ſun at any given time.*

This and the following Problem are added, becauſe that the common method of finding the longitude of a ſhip at ſea requires the aſſiſtance of three

perſons at the ſame time, with a watch truly regulated; for while one obſerver meaſures the angle between the moon and the ſun, or ſome fixed ſtar, a ſecond muſt take the altitude of the moon, and a third the altitude of the ſun or ſtar: But by this and the following Problem one obſerver may perform the whole; for he need only obſerve the apparent diſtance of the moon from the ſun or ſtar, noting the true time of the obſervation by a well-regulated watch; and he may afterwards calculate their altitudes very readily by theſe Problems.——*Note*, He muſt make 4 or 6 obſervations, as near as poſſible to one another, and then take a mean of them all; which will be much better than if he depended upon one obſervation.

Rule. To the log. verſed ſine, anſwering the diſtance of the obſervation from noon, add the log. coſine of the lat. per account, and the log. coſine of the ſun's declination, abating 20 from the index, and the ſum will be the log. of a number, which, being ſubtracted from the nat. ſine of the ſun's meridian altitude, with three cyphers annexed, will leave the nat. ſine of the ſun's altitude at the time required.

N.B. The altitude thus found will not be the apparent, but the true altitude.

Problem VII. *To find the altitude of the moon, or a ſtar, at any given time.*

Rule. To the given time add the ſun's right aſcenſion for that time, and the ſum will be the right aſcenſion of the mid-heaven: From this, (increaſed by 24 hours, if neceſſary) ſubtract the right aſcenſion of the moon or ſtar, and the remainder will be the horary angle, or diſtance of the moon or ſtar from the meridian: Then to the log. verſed ſine of this diſtance, add the log. coſine of the latitude and the log. coſine of the declination; and proceed as in the laſt Problem, for the ſun's altitude.——N.B. In all theſe Problems I have ſuppoſed Sherwin's tables to be made uſe of.

FINIS.